MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

CONSOLIDATION OF POROUS BACKFILL

Roy Greenman
Assistant Engineer of Soils

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Roy Greenmen
Assistant Engineer of Soils
Michigan State Highway Department

The Michigan State Highway Department has, during the past two years, carried on an investigation of the gradation and consolidation of porous backfill materials. The paper, prepared for the annual meeting of the A.R.B.A. Committee on Compaction of Soil held in Chicago February 16, 1947, covered the results of the studies to that date.

Additional field studies have been made dealing primarily with the consolidation of granular material used as structure backfill or in embankment. This paper is a brief summary of these studies and a resume of the conslusions made on the entire study.

During the past year the work has been devoted almost entirely to the development of the platform type of vibrator. Plate 1 shows the original platform vibrator mentioned in the previous paper. The first results were favorable and the unit was well suited for those relatively inaccessible areas around structures.

Following this preliminary work the vibrator was improved and modified to make a more efficient unit and Plate 2 shows one of the first modifications. The plate on the bottom of the three inch plank was removable and four different types of base plates were used in the study for the purpose of determining the one most effective in the consolidation of granular material. All of the plates used resulted in satisfactory densities, but some were more difficult to handle than others and consequently less efficient.

Further improvements were studied and it was found that by leaving off the three inch plank and using a base plate made up of 1" x 1" angle irons the

unit became self propelled. This type of vibrator is shown in Plate 3. Additional work on the self propelling idea resulted in the unit shown in Plate 4. This unit has been used on several projects. The results have been very satisfactory both in the degree of density obtained and the efficiency of getting such densities.

Densities equal to 95 per cent of maximum density were obtained, usually with one pass of the vibrator and on a 12 inch layer.

Additional work is being carried on, using heavier units and also connecting the units in gangs of eight to twelve for the purpose of consolidating granular bases and granular embankments. These developments in equipment will also be studied on field projects and in the State Highway Testing Laboratory at the University of Michigan at Ann Arbor.

The conclusions of the study to date are as follows:

The gradation of backfill material was found to be an important factor in any location where there is a possibility of infiltration of adjacent soil, subbase material, or infiltration of the backfill material into and through the drainage structure. Where there is no possibility of any of the above-mentioned conditions occurring, obviously the question of gradation is of less importance. Backfill around the sub-structure of bridges or culverts in areas where the adjacent soil is heavy clay and consequently would have no water moving through it, would not require gradation control. However, if a granular subbase were to be placed over the top of the backfill material, some precaution should be taken to prevent the infiltration of the subbase fines down into the backfill material.

The question of the necessity of consolidation of granular materials was definitely answered by this study in finding that volume changes as great as 19 per cent could and do occur in granular fills placed without consolidation. This volume change varies with the type of material and the method of placement, but it was found that all granular materials, unless properly consolidated when

placed, will consolidate under traffic and weathering, thereby resulting in settlement of the surface treatment.

The conclusions as regards the most efficient means of consolidating granular materials may change as data is obtained from additional studies. However, as a result of this study these conclusions are made:

1. Satisfactory densities can be obtained by hand tamping and mechanical tamping if the layers are not over 6 inches in thickness. The method is slow and expensive.
2. Penetrating vibrators, such as bullet-nosed concrete vibrators and vibrating spears or tines, are not efficient because the vibratory effect is confined to a very small area adjacent to the vibrating member.
3. The surface type vibrators such as the modified paving tube vibrators and the self propelled platform vibrators proved to be the most efficient. The platform type vibrator was found to give satisfactory densities on layers of material up to 12 inches in thickness. The paving tube type could be adapted to large unconfined areas, such as bridge approaches, embankments and granular bases. The platform type is especially suitable for those areas inaccessible to large equipment. The platform vibrator when used in a 'gang' of three or four units is also adaptable to larger areas.

It is further concluded that the cost of placing backfill when using vibrating equipment will be less than the cost when placed in accordance with the requirements of the current Standard Specifications which require tamping in thin layers.